IMPROVED HYDROGEN MASER PERFORMANCE

JPL has designed a better hydrogen maser, one with doubled reliability and greater frequency stability than current masers. Reliable and stable atomic frequency standards are critical to the precise navigation required for deep space exploration. The hydrogen maser provides the standards.

A hydrogen maser is an electronic oscillator which resonates at a frequency precisely determined by the natural properties of the hydrogen atom. In practice, hydrogen atoms are pumped into a storage bulb within a cavity, which they excite at a microwave frequency corresponding to the quantum electrical resonance of the atoms.

Doubled reliability resulted from improving the technique for coating the storage bulb. This improvement doubled the oscillator Q (a measure of sharpness of resonance) to 1.6×10^9, which permitted the rate of atomic hydrogen usage to be halved. This in turn doubled the expected lifetime of the internal vacuum pump, which feeds the hydrogen to the bulb. The pump is the current limiting factor in hydrogen maser reliability.

Greater stability is now possible because of better cavity and storage bulb mounting techniques. The mounts must have extreme mechanical and thermal stability to isolate the frequency of oscillation from external disturbances. The new three-point strut suspension for the cavity, for example, cuts thermal coupling by a factor of 3, with a corresponding increase in frequency stability.

Figure (opposite page): Hydrogen Maser Storage Bulb with improved bulb mounting is shown with the outside microwave cavity removed. The improved mounting provides greater thermal and mechanical isolation from outside disturbances.